

**ACHIEVING INFORMATION DOMINANCE:
SEVEN IMPERATIVES FOR SUCCESS**

Topical Area:

C4ISR and Space

Dr. Tom Kaye and Mr. George Galdorisi

Dr. Tom Kaye
Mr. George Galdorisi

Space and Naval Warfare Systems Center San Diego
Office of Science, Technology and Engineering
53560 Hull Street
San Diego, CA 92152-5001
(619) 553-2104 (voice)
(619) 553-6816 (fax)
tomkaye@spawar.navy.mil galdorig@spawar.navy.mil

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 2002		2. REPORT TYPE		3. DATES COVERED 00-00-2002 to 00-00-2002	
4. TITLE AND SUBTITLE Achieving Information Dominance: Seven Imperatives for Success			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S)			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Space and Naval Warfare Systems Center, San Diego, Office of Science, Technology and Engineering, 53560 Hull Street, San Diego, CA, 92152-5001			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES 2002 Command and Control Research and Technology Symposium (CCRTS)					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES 21	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

ABSTRACT

The importance of C4ISR (command, control, communications, computers, intelligence, surveillance, and reconnaissance) as a key enabler for warfighting success has long been recognized. What has been less clear is a means for U.S.-led joint and coalition forces to achieve C4ISR dominance. Understanding not just the operational needs and the technical requirements – but also the functional capabilities required to achieve this goal – can hasten the day when C4ISR dominance for United States military forces is more than a futuristic goal. We address a critical issue – how does the technical community achieve this goal? The overarching thesis of this paper is that in order to achieve C4ISR dominance, the technical community should neither chase means to overcome extant enemy operational capabilities nor attempt to push systems to the operational forces based solely on available technology. Rather, it should build to a discrete set of functional capabilities to achieve this C4ISR dominance. This paper identifies seven functional imperatives to achieve this C4ISR dominance over an adversary. We conclude that what has remained timeless from the days of Sun Tzu to today's conflicts are the universal needs of warfighters to have the right information, at the right place, at the right time.

ACHIEVING INFORMATION DOMINANCE: SEVEN IMPERATIVES FOR SUCCESS

by

Dr. Tom Kaye and Mr. George Galdorisi

An integrated joint and combined C4ISR capability is necessary to ensure that accurate and relevant information can be gathered swiftly from various sources and then securely transmitted to forces and their commanders.

Quadrennial Defense Review Report

September 30, 2001¹

When asked what single event was most helpful in developing the theory of relativity, Albert Einstein is reported to have answered, “Figuring out how to think about the problem.”

Men, Women, Messages and Media:

Understanding Human Communication²

The importance of C4ISR was recognized long before these words appeared in the most recent QDR. What has been less clear is a means for U.S.-led joint and coalition forces to achieve information dominance. ‘Thinking about the problem’ and understanding not

just the operational needs and the technical capabilities – but also the functions required to achieve this goal – can hasten the day when true information dominance is more than a futuristic goal.

Overview

The world was changing dramatically well before the September 11th terrorist attacks on the World Trade Center and the Pentagon shocked the nation and the world. Globalization – the international interaction of information, financial capital, commerce, technology and labor at speeds exponentially greater than previously thought possible – has been – and will continue to be – the motive force driving this profound world change.³

United States security policy must respond to globalization by shaping the emerging world order in a way that protects U.S. core values and promotes U.S. and allied vital interests. The Quadrennial Defense Review Report noted that the new United States security paradigm must be prepared to deal not just with expected enemy threats – but rather with extant and potential enemy capabilities that could threaten our interests.⁴

Building a U.S. military force with the size and scope to respond to a broad spectrum of potential enemy capabilities is a daunting task, especially given budget limitations faced by the Department of Defense (DoD). As the United States military

becomes more involved in Homeland Defense, it still needs to provide and maintain the robust forces for Forward Presence required by *Joint Vision 2020*.⁵ Thus, it is no longer possible to defer the procurement decisions to acquire the numbers of ships, aircraft, systems, sensors and weapons necessary to execute our National Security Strategy and National Military Strategy.⁶

Even more challenging are the coincident tasks of dealing with dramatic operational changes that have reshaped our mission areas since the end of the Cold War, while adjusting to technology innovations that have profoundly impacted the types of systems, platforms, sensors and weapons available to both U.S. forces and potential adversaries. As “mission creep” has impelled the United States military to take on increasing responsibilities, and as potential adversaries have acquired more sophisticated weapons in greater numbers, the pressure to come up with “another solution” has intensified. Technology upgrades have been proposed as one way offset the force structure deficit caused by this “mission creep.”

Based upon a number of comprehensive studies, it appears unlikely that the DoD budget will be increased enough to produce a significant number of new platforms. Rather, it is likely that the downward pressure on procurement accounts will only intensify, as the U.S. military finds additional ways to contribute to the war on terrorism and the imperatives of homeland defense.⁷ Therefore, another way must be found for the DoD to provide the wherewithal for United States military forces to achieve their goals.

The United States' military goals are operationalized in *Joint Vision 2020*, the DoD blueprint for creating a force that can dominate across the full spectrum of military operations including Homeland Security. *Joint Vision 2020's* principal focus is Full Spectrum Dominance, which is achieved through the application of interdependent joint operational concepts; Dominant Maneuver, Precision Engagement, Full Dimensional Protection, Focused Logistics, and Information Superiority.

Joint Vision 2020 recognizes that even in concert with potential allies, the United States does not have the sheer numbers of forces to achieve Full Spectrum Dominance without the under girding of Information Superiority to leverage the capabilities of these forces. Thus, *Joint Vision 2020* points out that achieving Information Superiority and C4ISR Dominance through technology insertion is the sine qua non of successful military operations and a necessary condition for U.S. forces to defeat potential adversaries.

The Challenge of Achieving Information Dominance

Information Dominance is a concept that is easy to articulate but difficult to achieve. To some, it means having more information than an adversary. In view of the technological prowess of U.S. forces, this surfeit of information is almost always a given. To others, it means having friendly platforms "linked" in some way that allows them to operate together as one entity. The Navy and Marine Corps achieved this at sea several years ago with the "IT-21" systems that provided heretofore unheard-of connectivity between and among platforms. What has not been achieved is the cultural leap, the

change in behavior and doctrine that enables our forces to leverage these capabilities in a way that ensures that they achieve Information Dominance over an adversary.

The road to achieving Information Dominance is fraught with additional pitfalls. One is tempted to build systems to overcome potential enemy operational capabilities. This has been our approach to acquisition for the past forty years. Define the requirements and the threat; consider alternative approaches; and then construct an acquisition strategy based upon the optimal, affordable, course of action. This approach served well in many areas. However, such an approach has not worked well in creating interoperability among systems. Nor has this approach worked well when the operational requirements are in rapid flux, as we have seen in the decade after the end of the Cold War.

A second approach to attempt to achieve Information Dominance is to build systems based upon the best currently available technology to provide the most technically advanced capabilities to our forces. This approach can fail miserably in areas like Information Technology, where the technology can move from generation to generation within eighteen months or less and, thus, far faster than our ability to equip the operating forces with the same technology within a generation. This approach also leads to interoperability challenges among our people and allies, a situation that plagues industry as well as the military.

One methodology that does hold the promise of being able to achieve this goal is to build to the functional capabilities necessary to achieve Information Dominance. This is the overarching conceptual framework of the DoD's recent movement away from platform-centric and towards network-centric operations – a United States military force built around the functional capabilities required to achieve Information Dominance.⁸

This functional view of Information Dominance emphasizes C4ISR capabilities that are needed across the spectrum of military operations. These functional imperatives for Information Dominance are both timeless and scenario independent – they are as germane today as when military forces communicated with each other via signal fires on land and flag hoists at sea. Achieving these functional imperatives ensures that a force has the right information at the right place at the right time – while preventing the enemy from doing so.

Functional Imperatives for Information Dominance

Taking a functional view of the C4ISR capabilities that are needed to achieve Information Dominance creates a common frame of reference that enables operators and technologists to communicate in a way that translates needs into capabilities and evaluates capabilities based on real - vice perceived - needs. Bridging these two “worlds” is important in and of itself, as few things are more futile than technologists building capabilities that operators do not need or cannot figure out how to use.

The functional imperatives required to achieve Information Dominance are essential building blocks and represent a necessary condition for ensuring that U.S. and allied forces - and not the enemy - have the right information at the right place at the right time. Together, the seven functional imperatives listed below ensure that a C4ISR capability is built that will enable the Joint Vision 2020 Force to prevail in any scenario:

- *Focused Sensing and Data Acquisition:* The expeditionary force faces a large littoral battlespace in many geographic regions. Yet commanders need situational awareness at some level over the whole battlespace. Depending upon the situation, they need more detailed information in some areas than others. This critical need for awareness is the rationale behind the United States Navy's revolutionary concept of FORCEnet and the Expeditionary Sensor Grid – means of sampling the battlespace so that forces can maneuver from the sea with the situational awareness needed to prevail in any conflict. Sensing the environment to gain situational awareness involves gathering data about the physical world through electromagnetic, acoustic, seismic, optic, and other measurement means. This can be accomplished with platform-borne sensors or with off-board assets from unattended sensors, unmanned air vehicles, satellites and intelligence sources. Focused sensing implies a concentration on things of interest, applying available sensing resources to obtain data and information on the area of interest while avoiding the fire-hose effect of gathering an overwhelming amount of data. Clearly, targeting-quality information requires a focusing of our data-sensing

capabilities. Networked sensors can be designed to collaborate autonomously to refine and enhance the information delivered.

- *Dynamic Interoperable Connectivity*: All warfighters must have reliable, secure, and flexible access to all other users and information sources. Dynamic Interoperable Connectivity is the conduit for all information, whether this information moves 10 feet or 10,000 miles, while the actual data path is transparent to the user. This connectivity can involve any number of people and machines, at various locations, all sharing common information resources – resources that serve many more needs than could be satisfied by static connections. This connectivity must be dynamic to address changing real-time needs of the warfighter and changes to the environment as bandwidth demands change with the scenario. As more forces are brought to bear in a conflict, the challenge for technologists is to support more users without slowing down the speed of the network.

- *Universal Information Access*: Meeting user information needs at all levels is the goal of Universal Information Access. The development of the Internet, the introduction of IT-21 to afloat users, the Tactical Data Net for the Marine Corps and, soon, the Naval Marine Corps Intranet for the shore-based infrastructure, all provide naval expeditionary forces – as well as joint and coalition forces joining them - with access to information that is revolutionizing the operators' information advantage. The warfighter must have enough information to make

informed decisions – but not so much as to drive him into information overload. Additionally, these warfighters must be able to access this universe of information without the need for specialized technical skills. This imperative balances three methods of accessing information; user information pull, producer information push, and preplanned information ordering. User pull provides a call-when-needed capability enabling users at all levels to access the info sphere to support various missions. Producer push enables command centers and higher headquarters to provide information whenever it is perceived that the warfighters have insufficient knowledge to formulate a request. Preplanned information includes both information assembled before a mission and information that is automatically updated during a mission.

- *Information Operations Assurance: Joint Vision 2020* points out the need for U.S. forces to have information superiority in order to dominate. Adversaries will try to deny the U.S. and its allies this key advantage. The need for information superiority to defeat an adversary makes the job of protecting the C4ISR infrastructure a critical component of Information Dominance. Assurance features provide the access controls, authentication mechanisms, confidentiality, and integrity features that enable the users to assert their identity and to access resources in both peer-peer and client-server interactions. The foundation of this assurance is a clear definition of what is supposed to happen and who is supposed to perform that action. A clear definition of what services a system is supposed to offer and who is authorized to avail themselves of these services enables the user

to receive these services without modification, disclosure, interruption or other unintended actions.

- *Consistent Situation Representation:* Human comprehension of complex events comes from a shared awareness of the battlespace across all echelons of command. Information is processed, fused, and presented to form an understanding of events, trends, and intentions that combine to provide a consistent picture of the battlespace. For forces to act in a synchronized fashion, this information must be spatially, temporally, and content consistent. While every user at every level is not necessarily required to view the identical common operational picture at all times, each user must have access to the same accurate and timely information, and users at lower echelons of command must have a means to determine both what higher level commanders want to see as well as what they are viewing at various stages of the operation. Importantly, the information display must be easily comprehensible to the viewer. In the press of time-critical action, this information display must support the decision-maker, not add to his stress.

- *Distributed Collaboration:* This imperative involves maintaining fully connected and transparent interactions among users and providing tools and connectivity for collaboration at the user level. Most systems operators provide support to those warfighters operating in the battlespace. All of these operators need some information technology tools to help collaborate with those people who need

support. These tools must support geographically dispersed users in conducting on-line planning, coordination, and synchronized execution – thus supporting analysis, planning and interoperability between units. Quick reaction by dispersed forces results from the effective collaboration between and among multiple users. When a force includes allied and coalition partners – many of who may not have trained extensively with U.S. forces - the need for distributed collaboration is even greater. Collaboration tools must allow interactions at various command levels, and between and among multiple job functions and organizational locations.

- *Resource Planning and Management:* Every army that ever marched or navy that ever sailed has been resource limited. In an era of increasing operational demands, U.S. and allied forces must become more expert in resource allocation. Often, mission success or failure hinges on effective use of available resources. This imperative involves providing the tools necessary to identify and allocate resources for any given task or to meet an unplanned contingency. This management of resources is especially important as it relates to people, dynamic spectrum management, collection management, and data and information management. Those supporting the warfighters must be agile and flexible enough to maneuver and allocate information resources rapidly. Importantly, C4ISR systems must deliver the status of both friendly and enemy sensors, systems, platforms and weapons in real time so that forces may self-synchronize and either take advantage of opportunities or hedge against vulnerabilities.

Taken together, these seven functional imperatives describe how a military force uses technology, along with an intelligent application of doctrine, tactics, techniques and procedures, to achieve Information Dominance over an adversary. These seven functional imperatives are necessary conditions to achieve this dominance – not attributes that ensure it automatically. Importantly, for the operator and the technologist, they provide an essential, common, frame of reference.

These imperatives are unique – but they also map into other useful taxonomies that deal with achieving Information Dominance. For example, a taxonomy such as the well-known “OODA Loop” (Observation, Orientation, Decision, Action) is critically dependent on warfighters at all levels achieving these seven functional imperatives in order to cause this “Loop” to run at the speeds it needs to in order to achieve success. Similarly, the “System of Systems” taxonomy presented by former Vice-Chairman of the Joint Chiefs of Staff, Admiral Bill Owens in his recent book *Lifting the Fog of War*, which envisions joint forces “seeing,” “telling,” and “acting” presumes that these seven imperatives are met by military commanders who have near-perfect C4ISR Dominance over the entire battlespace.⁹

A Roadmap for Achieving Information Dominance

Utilizing the taxonomy of these seven imperatives guides both the operational application of C4ISR and the development of emerging technologies. For the technologist, they are a star to steer by in trying to package technology developments into useful mission capability packages. At the operational level, warfighters seeking to achieve Information Dominance will become aware of what functions and attributes they are less well able to perform than others and will place the appropriate demand function on the technical community to “pull” the right technologies forward to satisfy that functional imperative. In like manner, within the technical community, scientists and engineers typically find it easier to see the benefits of “pushing” a technology that maps to a particular functional imperative rather than trying to extrapolate a particular technology to meet a perceived operational need.

This taxonomy has been operationalized in the Navy S&T and R&D community. At one navy laboratory, the Space and Naval Warfare Systems Center San Diego (SSC SD), scientists and engineers map over 1200 programs and projects to a “Technology Road Map” that bins these emerging technologies based on their ability to address one or more of these seven functional imperatives. Far from an academic exercise, this “binning” enables associations to be made between and among often disparate programs and projects, resulting in synergy of effort and mutual collaboration.

The validity of this “Seven Functional Imperatives Taxonomy” and the benefits of technology binning was used in response to the tragic events of September 11, 2001.

In the wake of these attacks, the SSC SD was able to rapidly and effectively answer calls for technologies in response to urgent warfighter needs by presenting this Seven Functional Imperative-driven Technology Road Map as an instant resource to warfighters seeking technologies that could be employed to defeat terrorism in the near term.

Some would suggest that the operational and technical challenges facing our joint forces today are so profound that attempting to develop a road map for Information Dominance is an exercise in futility – something akin to a startup company developing a seven-year business plan. They would leave it to the operational forces to make demands for technology as the need arises and for technologists to push technologies forward when they see an opportunity. But effective companies do plan – many plan across a broad timeline. The old saw still holds; failing to plan is planning to fail.

Developing a road map to achieve Information Dominance is challenging. Leaders must leaven insistent operational demands and the excitement of technological innovation with a sharp focus on just what functions need to be performed. Once candidate technologies to map to these functions are surfaced through an aggressive S&T and R&D process, operational experimentation must test these technologies in the harsh operating environment where operators – not technologists – determine their utility.

Candidate technologies passing this test must then be composed into integrated systems, not added-on to a platform as one more stovepiped system, and the acquisition commands must be mobilized to deliver these functional capabilities in a timely manner. Finally, viable doctrine, tactics, techniques and procedures must be developed so that operators will have the tools to fully leverage these capabilities. This represents the surest way to deliver an integrated package to the operational forces that will enable them to achieve Information Dominance over any adversary.

Information Dominance is Achievable

As great as the strategic, operational and technical challenges to achieving Information Dominance appear today, they are arguably no greater than the technical challenges that have preceded them. At the strategic and operational level, the past several millennia have seen global warfare and the potential for global thermonuclear war, as well as other cataclysmic events that are at least as profound as the clash of civilizations underway today. At the technical level, while many of today's innovations in systems and sensors impact warfighting in a dramatic way, their impact on warfare must be placed in the context of innovations over these same millennia ranging from the longbow, to the cannon, to steam propulsion for ships, to the rail gun.

What has remained timeless from the time of Sun Tzu to today's conflicts are the universal needs of warfighters to have the right information, at the right place, at the right time - and the concomitant ability to deny their adversaries this capability. Focusing our operational needs and technical innovations on these seven functional imperatives for Information Dominance provides a clear path to ensure that our warfighters will prevail in any conflict.

NOTES

1. *Quadrennial Defense Review Report* (Washington, D.C., Department of Defense, 2001), p. 46.
2. Wilbur Schramm and William Porter, *Men, Women, Messages and Media: Understanding Human Communication* (New York, Harper and Rowe, 1982).
3. Richard Kugler and Ellen Frost, Eds. *The Global Century: Globalization and National Security* (Washington, D.C., National Defense University Press, 2001).
4. *Quadrennial Defense Review Report* (Washington, D.C., Department of Defense, 2001).
5. *Joint Vision 2020: America's Military – Preparing for Tomorrow* (Washington, DC, Joint Chiefs of Staff, June 2000).
6. *A National Security Strategy for a New Century* (Washington, DC, The White House, December 1999) and *National Military Strategy: Shape, Respond,*

Prepare Now – A Military Strategy for a New Era (Washington, DC, Department of Defense, 1999).

7. See, for example, the three publications of the United States Commission on National Security in the 21st Century (commonly referred to as the Hart-Rudman Commission after the two Co-Chairman Gary Hart and Warren Rudman) which include: *New World Coming: American Security in the 21st Century* (Washington, DC, September 1999), *Seeking a National Strategy: A Concert for Preserving Security and Promoting Freedom* (Washington, DC, April 2000), and *Road Map for National Security: Imperative for Change* (Washington, DC, March 2001); Daniel Goure and Jeffrey Ranney, *Averting the Defense Train Wreck in the New Millennium* (Washington, DC, Center for Strategic and International Studies, 1999); and Michele Flournoy, ed. *QDR 2001: Strategy-Driven Choices for America's Security* (Washington DC, National Defense University Press, 2001); for some of the most reasoned arguments regarding the overall defense budget. See also Ronald O'Rourke, *CRS Report to Congress: Navy Ship Procurement Rate and the Planned Size of the Navy: Background and Issues for Congress* (Washington, DC, Congressional Research Service, August 28, 2001), pp. 1-6, for a similar analysis focused on the Navy budget.
8. *Network Centric Operations: A Capstone Concept for Naval Operations in the Information Age* (Newport, Rhode Island, Navy Warfare Development

Command, 2001). See also *Network Centric Warfare: Report to the Congress* (Washington, DC, Department of Defense, 2001).

9. See, for example, David Alberts, et al, *Network Centric Warfare: Developing and Leveraging Information Superiority* (Washington, DC, Department of Defense, 1999), William Owens *Lifting the Fog of War* (New York, Farrar, Straus and Giroux, 2000), David Alberts, et al, *Understanding Information Age Warfare* (Washington, DC, Department of Defense, 2001), and John Arquilla and David Ronfeldt, *Networks and Netwars* (Santa Monica, CA, RAND National Defense Research Institute, 2001).